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Clot length does not impact outcome following thrombectomy

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ABSTRACT

Background and aims: Clot length was associated with outcome after treatment with intravenous tissue plasminogen activator (tPA) in patients with stroke secondary to emergent large vessel occlusions (ELVO) but data regarding the influence of clot length on outcome after thrombectomy is lacking.

Patients and methods: Prospectively accrued data on consecutive patients with ELVO treated with thrombectomy was analyzed. Data on demographics, risk factors, stroke severity, survival and occurrence of symptomatic intracranial hemorrhage (sICH) was collected. Procedural details including clot length measured on the pre-thrombectomy digital subtraction angiograms in multiple projections were collected. Functional outcome was determined with the modified Rankin Scale (mRS) 90 days post stroke and mRS ≤ 2 was considered as favorable outcome.

Results: Data was collected for 94 patients that fulfilled entry criteria. On univariate analysis clot length did not differ between patients with favorable or unfavorable outcomes. Clot length also did not influence the rates of sICH or mortality. On multivariate logistic regression age and stroke severity remained significant modifiers for favorable outcome. In a second regression model age, poor collaterals, the number of passes needed for recanalization and the magnitude of change in neurological deficits between presentation and discharge remained significant modifiers of outcomes. However, clot length had no effect on outcome in both models.

Conclusions: In patients undergoing thrombectomy for ELVO, clot length has no effect on functional outcomes, mortality or sICH. Therefore, patients with ELVO should not be excluded from thrombectomy based on lot length.

Ischemic stroke can be treated with either intravenous tissue plasminogen activator (tPA) or thrombectomy [1]. Early reperfusion of the occluded vessel can be life-saving in patients with emergent proximal large vessel anterior circulation occlusions (ELVO) [2].

In tPA-treated patients, larger clots were associated with higher likelihoods for poor outcome [3,4]. However, the influence of clot length on outcome after thrombectomy remains less clear. While larger clots could potentially be more resistant to endovascular treatment, the common practice of using repeated stentriever passes and thrombus aspirations as needed until recanalization is achieved could potentially make clot length less relevant. Indeed, older pre-stentriever era studies showing a correlation between clot length and outcome [5] while newer stentriever-based thrombectomy studies failed to reproduce these results [6–9]. Therefore, we aimed to study the effects of clot length on functional outcome in a homogenous group of patients with ELVO that underwent thrombectomy.

1. Patients and methods

We analyzed prospectively accrued data from a database of consecutive patients with ELVO that were treated with thrombectomy [10]. The data presented here is an extension of data presented in previous studies using data contained in the same database with addition of data from new patients that were entered over time. The local IRB granted permission to include anonymous patients into the data set. The current study included patients who experienced an acute ischemic stroke with occlusion of the internal carotid artery or proximal middle cerebral artery proven on vascular imaging. All patients underwent thrombectomy with stentrievers as the primary mode of recanalization. Patients with occlusions involving other arterial supply and patients who were not primarily treated with stentrievers (e.g. aspiration technique or intra-arterial thrombolysis) were excluded. Bridging thrombolysis with systemic tPA prior to thrombectomy was allowed.

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Fig. 1. Measurement of clot length on DSA.
Images were obtained during endovascular treatment of acute stroke prior to stentriever deployment. Panels a-b show acute distal right ICA occlusion and panels c-d from a separate patient with left proximal MCA occlusion. Clot lengths were measured as the distance from proximal vessel occlusion (clot start) to the most proximal post-occlusion site that allowed distal vessel visualization upon contrast injection (clot end) as shown in panels b and d. Multiple projections were studied for each case including oblique (a, c), anterior-posterior (b, d) and intermediate position views.

We collected demographics and vascular risk factor profile. Neurological deficits were measured with the National Institutes of Health Stroke Scale (NIHSS) at admission and discharge [11]. Stroke etiology was classified with the TOAST classification [12]. We also assessed time metrics, imaging variables including clot visibility on the admission non-contrast CT, the Alberta stroke program early CT score (ASPECTS) before and after treatment and collateral status on the admission CTA [13].

We used digital subtraction angiograms in several angles and projections for clot length measurements. Specifically, clot length was measured in mm as the distance from the proximal site of vessel occlusion until the distal part of evident flow following contrast injection after transection of the clot with the guidewire (Fig. 1). The distal segment of the clot was identified in each patient by using multiple microinjections. The clot lengths were measured by three independent raters and the mean was used for statistical analyses.

Data on procedural variables including the thrombolysis in cerebral infarction (TICI) score [14] at the end of the procedure and the number of passes needed to achieve the best possible recanalization were also studied. TICI2b-3 was considered as favorable target vessel recanalization.

Modified Rankin Scale (mRS) [15] at 90 days from stroke was used for functional outcome assessments and an mRS ≤ 2 was considered as favorable outcome. Outcome was also assessed by survival and symptomatic intracranial hemorrhage (sICH) rates determined according to the ECASS III criteria [16].

For the purpose of the current analysis patients with favorable outcome (mRS ≤ 2) were compared to those with unfavorable outcome (mRS ≥ 3).

Statistical analysis was performed using the SPSS program. $P < 0.05$ was considered as significant. The chi- squared test or Fisher's exact test were used to explore the link between qualitative variables. The student's *t*-test was used to compare quantitative variable. We used Eta statistics to evaluate possible correlations between continuous and categorical variables. We next used two multivariate logistic regression models to test whether clot length had an impact on favorable outcome. In the first model we included variables that were shown to affect outcome in previous studies including age, reperfusion status, and stroke severity [17,18] in addition to clot length. In the second model we entered variables that were found to be significantly associated with the dependent variable (favorable vs. unfavorable outcome) in the univariate analysis. Specifically, this model included age, vascular risk factors such as the presence of hypertension, atrial fibrillation and ischemic heart disease, number of passes needed to achieve recanalization, clot length, reperfusion status and the change in neurological deficit from onset to discharge from acute care calculated as delta in NIHSS scores.

2. Results

During the study period 94 patients with an occlusion at the proximal middle cerebral or internal carotid artery were treated. Of those, only 86 patients had validated 90 day post stroke outcome data and were included in the final analysis. Main reasons for lack of data were residence outside the catchment area ($n = 5$) and lost to follow up ($n = 2$).

On univariate analysis clot length showed no significant association with clinical outcomes including survival, sICH and functional independence defined as mRS 0–2 after 90 days (Table 1).

Factors that were associated with higher likelihood of favorable functional outcome at 90 days were age, neurological severity as baseline, collateral and reperfusion status (Table 2).

We could not find a significant correlation between TICI 2b-3 reperfusion status and clot length with an Eta statistics value of 0.165. Similarly, we could not find a significant correlation between the number of passes used and clot length with an Eta statistics value of 0.141.

In the first model of multivariate logistic regression that controlled for age, baseline stroke severity and reperfusion state as well as clot length, only age (OR 0.08, 95%CI 0.88–0.96, $p < 0.001$) and baseline stroke severity (OR 0.13, 95%CI 0.79–0.97, $p = 0.005$) remained significant modifiers for the chances of obtaining a favorable outcome (Table 3).

We then used a second model of logistic regression that controlled for age, vascular risk factors, reperfusion state, change in neurological

Table 1
Effects of clot length on Survival sICH and functional outcome at 90 days post stroke among thrombectomy-treated ELVO patients.

	P-Value	Clot length (± SD)
Survival		0.780
Yes	17.9 ± 5.6	
No	17.3 ± 8.2	
sICH		0.29
Yes	13.9 ± 6.7	
No	18.1 ± 7.8	
Favorable outcome (mRS 0–2)		0.94
Yes	17.8 ± 6.7	
No	17.9 ± 8.6	